

## **Appendix A**

### **HELP MODEL**

## HELP Model Predictions for Leachate Generation at Circle "C" Landfill

The HELP computer model program has been run on the existing landfill site with and without the requested vertical expansion. That data is summarized below and in the attached computer printouts.

The HELP Model requires input data on the number of layers, thickness of layers, purpose (type) of layers, hydraulic characteristics of the layers (texture) and climatologic data. The climatologic data is based on temperature and rainfall for the Vancouver area, using the distribution of Portland's rainfall as a synthetic rainfall generator. Average monthly temperature and rainfall data for Vancouver were used to make the synthetic rainfall and evapotranspiration data more accurate.

The integrity of the reported clay liner beneath the waste and the effectiveness of the recently installed leachate collection system are unknown. Therefore, these elements were not included and the landfill was initially modelled as a closed, capped facility with no leachate collection system or bottom liner. Experience with the HELP model, as well as common sense, indicates that virtually all fluids penetrating a landfill's top cap exit either through the leachate collection system or by percolating though the base of the landfill. With the percentage of leachate captured by Circle "C"'s collection system uncertain, conservative design requires that leachate handling systems are based on the full volume penetrating the cap. As a result, the critical value for design purposes is the percolation from Layer 2 (the clay liner).

The landfill was modelled using the default soil characteristic values in the model that most nearly matched the landfill materials itself. A one foot top soil layer ( $5 \times 10^{-4}$  cm/sec) overlies a 2 foot clay cap ( $10^{-7}$  cm/sec). Demolition wastes were modeled with municipal hydraulic waste characteristics with a permeability of  $2 \times 10^{-4}$  cm/sec and the initial modelled thickness was 75 feet. In the second model run, a 65 foot layer of waste was modeled to

examine the thinner sections of the landfill. Native soils underlie the existing landfill and were not modelled.

Two runs were completed. The first run was of the closed landfill in its present configuration of about 75 feet of waste. The second run was modelled to represent the area between the existing northeast face of the landfill and the berm downcanyon of this face, which will have a maximum thickness of 65 feet.

The results (see printouts) indicate that the landfill, at 75 feet, will allow an average of 3,600 cubic feet per year per acre to pass through. When the landfill thickness is reduced to 65 feet, the vertical percolation will not change significantly but remains approximately 3,600 cubic feet per year per acre.

Leachate hauling records indicate that the collection system does indeed capture significant quantities of leachate. These records show an average of 5000 gallons/day were collected from the open landfill during January 1990, a month of extremely heavy rains. Obviously, the reported clay bottom liner and/or the native soils underlying the site provide a barrier to downward migration sufficient to cause significant quantities of leachate to exit via the collection system.

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CIRCLE C LANDFILL  
CLOSURE - 75 FEET  
1-6-89

GOOD GRASS

LAYER 1  
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VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.3980 VOL/VOL
FIELD CAPACITY	=	0.2443 VOL/VOL
WILTING POINT	=	0.1361 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0005039999378 CM/SEC

LAYER 2  
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BARRIER SOIL LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000001000000 CM/SEC

LAYER 3  
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VERTICAL PERCOLATION LAYER

THICKNESS	=	900.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2764 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999949 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER = 80.12  
TOTAL AREA OF COVER = 43560. SQ FT  
EVAPORATIVE ZONE DEPTH = 28.00 INCHES  
UPPER LIMIT VEG. STORAGE = 2.3880 INCHES  
INITIAL VEG. STORAGE = 2.3820 INCHES  
SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND  
SOLAR RADIATION FOR PORTLAND OREGON

MAXIMUM LEAF AREA INDEX = 3.30  
START OF GROWING SEASON (JULIAN DATE) = 124  
END OF GROWING SEASON (JULIAN DATE) = 287

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
38.80	42.60	44.70	49.10	54.70	59.70
64.10	64.20	60.80	53.20	45.00	40.70

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	7.44 1.18	4.49 1.44	4.63 2.55	3.34 5.01	2.39 5.62	1.56 7.70
STD. DEVIATIONS	2.20 0.92	1.27 1.16	1.77 1.96	1.13 1.28	1.13 1.82	1.02 2.48
RUNOFF						
TOTALS	6.697 0.004	3.117 0.061	1.855 0.359	0.329 2.114	0.038 4.275	0.021 6.860
STD. DEVIATIONS	2.262 0.012	1.267 0.208	1.499 0.964	0.563 1.301	0.093 1.868	0.096 2.516
EVAPOTRANSPIRATION						
TOTALS	0.655 1.202	1.548 1.382	2.843 1.723	3.484 2.074	2.539 0.995	1.662 0.615
STD. DEVIATIONS	0.131 0.800	0.207 1.034	0.362 1.101	0.832 0.455	1.117 0.144	0.935 0.112

PERCOLATION FROM LAYER 2

TOTALS	0.1313	0.1171	0.1213	0.0987	0.0432	0.0047
	0.0050	0.0091	0.0199	0.1024	0.1238	0.1310
STD. DEVIATIONS	0.0005	0.0019	0.0060	0.0175	0.0253	0.0109
	0.0084	0.0153	0.0232	0.0209	0.0025	0.0010

PERCOLATION FROM LAYER 3

TOTALS	0.0843	0.0770	0.0847	0.0821	0.0848	0.0818
	0.0841	0.0838	0.0808	0.0834	0.0809	0.0837
STD. DEVIATIONS	0.0024	0.0023	0.0024	0.0023	0.0023	0.0022
	0.0023	0.0023	0.0022	0.0022	0.0021	0.0022

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	47.36 ( 5.759)	171908.	100.00
RUNOFF	25.729 ( 5.494)	93395.	54.33
EVAPOTRANSPIRATION	20.721 ( 3.025)	75218.	43.76
PERCOLATION FROM LAYER 2	0.9077 ( 0.0482)	3295.	1.92
PERCOLATION FROM LAYER 3	0.9914 ( 0.0000)	3599.	2.09
CHANGE IN WATER STORAGE	-0.084 ( 0.082)	-304.	-0.18

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	2.96	10744.8
RUNOFF	2.952	10716.4
PERCOLATION FROM LAYER 2	0.0043	15.5
HEAD ON LAYER 2	6.5	
PERCOLATION FROM LAYER 3	0.0029	10.5
SNOW WATER	1.59	5755.6

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3980

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1279

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	2.38	0.3966
2	10.32	0.4300
3	247.09	0.2745
SNOW WATER	0.00	

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CIRCLE C LANDFILL  
CLOSURE - 65 FEET THICK  
1-6-89

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GOOD GRASS

LAYER 1  
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-- VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.3980 VOL/VOL
FIELD CAPACITY	=	0.2443 VOL/VOL
WILTING POINT	=	0.1361 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0005039999378 CM/SEC

LAYER 2  
-----

BARRIER SOIL LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0000001000000 CM/SEC

LAYER 3  
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VERTICAL PERCOLATION LAYER

THICKNESS	=	780.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2764 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.0001999999949 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER = 80.12  
TOTAL AREA OF COVER = 43560. SQ FT  
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64.10	64.20	60.80	53.20	45.00	40.70

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

PRECIPITATION

TOTALS	7.44	4.49	4.63	3.34	2.39	1.56
	1.18	1.44	2.55	5.01	5.62	7.70
STD. DEVIATIONS	2.20	1.27	1.77	1.13	1.13	1.02
	0.92	1.16	1.96	1.28	1.82	2.48

RUNOFF

TOTALS	6.697	3.117	1.855	0.329	0.038	0.021
	0.004	0.061	0.359	2.114	4.275	6.860
STD. DEVIATIONS	2.262	1.267	1.499	0.563	0.093	0.096
	0.012	0.208	0.964	1.301	1.868	2.516

EVAPOTRANSPIRATION

TOTALS	0.655	1.548	2.843	3.484	2.539	1.662
	1.202	1.382	1.723	2.074	0.995	0.615
STD. DEVIATIONS	0.131	0.207	0.362	0.832	1.117	0.935
	0.800	1.034	1.101	0.455	0.144	0.112

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	0.0050	0.0091	0.0199	0.1024	0.1238	0.1310
STD. DEVIATIONS	0.0005	0.0019	0.0060	0.0175	0.0253	0.0109
	0.0084	0.0153	0.0232	0.0209	0.0025	0.0010

PERCOLATION FROM LAYER 3

TOTALS	0.0838	0.0766	0.0842	0.0817	0.0843	0.0813
	0.0836	0.0832	0.0802	0.0827	0.0803	0.0832
STD. DEVIATIONS	0.0025	0.0024	0.0025	0.0024	0.0025	0.0024
	0.0024	0.0024	0.0023	0.0023	0.0022	0.0023

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	47.36 ( 5.759)	171908.	100.00
RUNOFF	25.729 ( 5.494)	93395.	54.33
EVAPOTRANSPIRATION	20.721 ( 3.025)	75218.	43.76
PERCOLATION FROM LAYER 2	0.9077 ( 0.0482)	3295.	1.92
PERCOLATION FROM LAYER 3	0.9850 ( 0.0000)	3576.	2.08
CHANGE IN WATER STORAGE	-0.077 ( 0.082)	-281.	-0.16

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	2.96	10744.8
RUNOFF	2.952	10716.4
PERCOLATION FROM LAYER 2	0.0043	15.5
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SNOW WATER	1.59	5755.6

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3980

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1279

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	2.38	0.3966
2	10.32	0.4300
3	214.03	0.2744

SNOW WATER 0.00